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# Travel to the 10th International Asparagus Symposium, Japan August/September 2001

R D Davis
Queensland Department of Primary Industries

Project Number: VX01014

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**VX01014 (31/03/02)**

# Travel to the 10th International Asparagus Symposium- Japan August/September 2001

**FINAL REPORT**

**R D Davis**

**Queensland Department of Primary Industries**

VX01014


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This Report describes the circumstances leading to my attendance at the 10th Asparagus Symposium in Niigata, Japan during August/September 2001, the information gathered at the symposium and the subsequent transfer of that information to Queensland asparagus growers.


The Project was funded through a contribution made by Queensland asparagus growers and supported by matching funding by Horticulture Australia Ltd. The Queensland Department of Primary Industries provided the salary component of my time while involved in the Project.




R. D. Davis 28.03.02

(R D Davis) (Date)

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# MEDIA SUMMARY

The 1999-2000 asparagus season was a tumultuous one for Queensland producers. Three new foliar diseases became established in crops during the year and became a focus of concern to the growers. Asparagus rust and Phomopsis stem blight are now endemic in southern Queensland production areas, while anthracnose currently remains restricted to the north of the state. All are potentially serious diseases.

International asparagus research symposia are held each five years to highlight and discuss developing trends in all aspects of asparagus production. My attendance at the 10$^{th}$ Symposium held in Japan in August 2001 presented a tremendous opportunity to gather disease management information and establish a useful network of contacts. In addition, I delivered a paper to about 130 symposium delegates describing the impact of these new asparagus diseases in Australia.

Asparagus rust is apparently not a constant, serious problem elsewhere. In most countries the disease fluctuates in significance. It was considered by experienced researchers I met that asparagus rust will eventually develop similarly in Australia and New Zealand and should be relatively easily managed using judiciously timed applications of fungicides and producer attention to trash destruction procedures over winter.

Phomopsis stem blight management is extremely problematical in countries where it occurs. Japan and China claim stem blight as the major problem in asparagus production in their countries. Asian management methods will have little appeal in Australia but discussions with stem blight researchers raised issues that can be used by Australian producers and researchers to understand the epidemiology of this disease and develop technology better suited to local production methods.

Asparagus anthracnose disease appears not be found elsewhere. The disease may be present in some Asian production areas but not recognised as anthracnose, consequently no targeted research has been directed to the causal fungus, *Colletotrichum gloeosporioides*. It appears other countries will look to Australian researchers for information on this problem should it develop further.

Crop surveys and discussion meetings with Queensland producers prior to and following my attendance at the symposium ensured an informed approach to the trip and allowed rapid information transfer on my return.

# EXPECTED OUTCOMES

Queensland asparagus growers remain as independent producers without any overarching representative body. Most seem satisfied with this arrangement and they meet together only in times of some crisis. Three new asparagus diseases appearing within a season presented such a crisis. The growers were aware of the forthcoming $10^{th}$ Asparagus Symposium in Japan and decided to provide financial support to send a researcher to this symposium. Collectively, Queensland asparagus growers indicated they saw my attendance as a means to:

- gather disease management information for immediate application in Queensland;
- identify active researchers in disease management and develop a network of overseas contacts who could be relied upon to provide advice and guidance on asparagus disease management issues into the future;
- gauge the significance of these diseases elsewhere;
- gain an understanding of the epidemiology of the diseases.

Although growers ideally wanted specific disease management outcomes, most were circumspect enough to understand that the chances of a quick solution to the problem of disease management were remote.

# RESULTS OF DISCUSSIONS

- **Visit to the Tokyo Central Wholesale Markets (Ohata Market) and Meeting with Mr Tetsuo Kudo of Tokyoseika Co Ltd**

1,732,770 tonnes of vegetables are sold in these markets on average each year. Although Australian asparagus is currently being exported to Japan, much of it bypasses these markets and is sold directly to wholesalers and supermarkets. A small volume of Australian asparagus does pass through these markets but unfortunately none was on the floor at the time of the visit. Only a small amount of fresh asparagus from Nagano and Fukushima Prefectures had been delivered for auction that morning. About 6000 tonnes of asparagus is sold/year through this market.

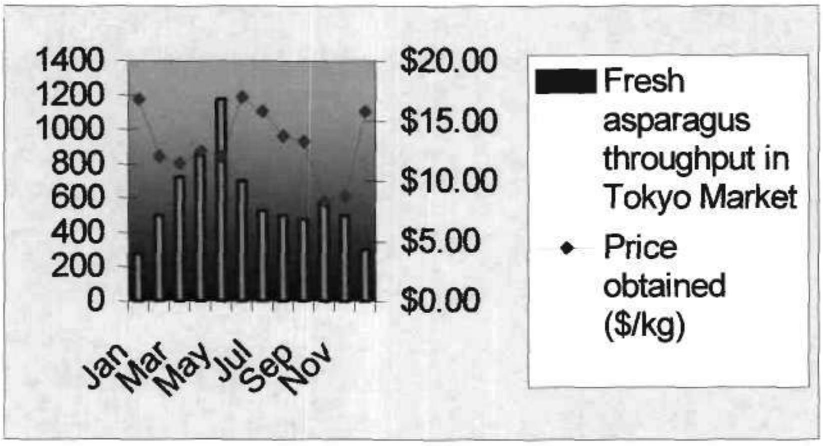
Following the inspection of the marketing facilities, discussions were held with Mr Kudo of the marketing company, Tokyoseika Co Ltd. The planted area of asparagus in Japan has decreased since 1990 from 10,490 ha to about 6,500 ha in 2000. Officially, this is the result of increased imports and a lack of farm labour. We were informed that asparagus diseases have also had a significant impact on asparagus production in Japan. The average annual price of fresh imported asparagus is $13-15/kg, although the highest price last year was $18/kg in June and the lowest was $8/kg in October. The price paid for imported asparagus is always much lower than for domestic product. Often the price paid for imported product from the USA is about 1/3 that paid for local asparagus ($9 for USA product cf $25 for asparagus from Japan). No figures were available for Australian asparagus. Table 1 provides some statistics relevant to total volume of imported asparagus (including fresh produce that is moved through the Tokyo markets and that which does not).

Table 1. Asparagus imports to Japan

| Year | Total (tonnes) | Australia | USA | Mexico | Philippines | Thailand | NZ | China | Peru |
|---|---|---|---|---|---|---|---|---|---|
| 1991 | 12482 | 2909 | 3132 | 2323 | 909 | 1646 | 1493 | 24 | 40 |
| 1994 | 21270 | 3147 | 6899 | 4157 | 3309 | 1826 | 1228 | 195 | 464 |
| 1998 | 19894 | 5445 | 3588 | 3819 | 4166 | 1193 | 1255 | 323 | 65 |
| 2000 | 24767 | 6086 | 5454 | 4914 | 4294 | 1895 | 1385 | 438 | 215 |

Much emphasis was placed on the importance of spear quality. Japanese quality is determined by spear thickness and head tightness. Grades are determined by a combination of these two characters with the top grade designated LL (or 2L) which has "fine quality, shape and colour; no diseases, insects and injuries; a tight head". There has to be 2-3 spears of this quality in a 150g bunch. Should quality be lower but the size grading the same as LL, the grade is called "Thick". L grade requires 4-11 spears/150g bunch and M grade 12-20 spears/150g bunch. Another grade is called "Slender" which contains 21-40 spears and is of a lower quality in relation to colour, shape and head tightness.

Figure 1. Throughput (tonnes) of total fresh asparagus at Tokyo Market in 2000.




## • Visit to Mr Kinjiro Obinata's asparagus farm, Nagano Prefecture

A very productive hour was spent visiting an asparagus farm in northern Nagano Prefecture (Tokiwa, Iiyama City). Mr Obinata's farm is 313m above sea level and he grows rice and asparagus on a sandy loam soil. His asparagus rows are 1.8m apart (cf 2-2.5m apart in Australia) and plants within rows are 30cm apart (the same as Australia). He and most other growers in this area stake the fern using two poles on either side of the bed and wire along the beds to keep fern from falling between the rows. Mother fern production occurs from April to mid-October each year. Mr Obinata's production is 15t/ha from about 0.35 ha/year.

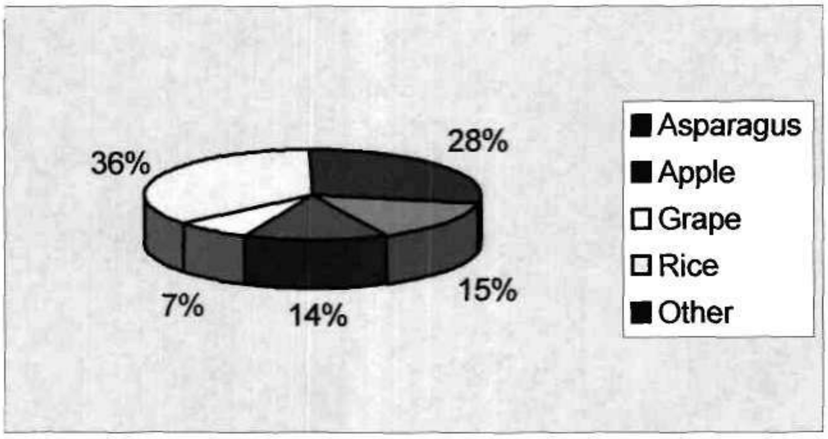
The main disease he attempts to control is Phomopsis stem blight. He uses three fungicides (chlorothalonil, Bordeaux mixture and carbendazim). Most years he applies 14 sprays. He furrow irrigates to avoid wetting the fern and establishing new epidemics. He uses a self-propelled, tracked, double-row sprayer which uses a front-mounted vertical boom on which is mounted 10 nozzles (5 pairs of two nozzles). His sprayer carries 300L of fungicide and he applies about 4000L/ha to obtain maximum coverage. Very little Phomopsis was found on this farm. He rarely gets rust and doesn't have to contend with too many other diseases.

## • Meeting with asparagus farmers in Nakano City

A large contingent of Japanese growers attended a meeting and lunch with Symposium delegates at Nakano City to discuss Japanese asparagus production in Nagano Prefecture. The Symposium was simultaneously translated for non-Japanese speaking delegates.

Around 1230ha of asparagus are grown in Nagano Prefecture each year. This area is slightly down compared with past production. Part of the reason for this is the disease Phomopsis stem blight and also because of low prices paid recently in comparison to other primary produce from this area. Figure 2 indicates asparagus production relative to other primary production in Nagano Prefecture.

Figure 2. Primary production in northern Nagano Prefecture.




There are a total of 7568 farms in this Prefecture and asparagus is produced on 2751 (36%) of them. The average asparagus planting/farm is 0.25ha. Most production occurs at between 330-800m above sea level. About 30% of Japan's domestic asparagus is produced in Nagano Prefecture (about 7500 tonnes). Production occurs all year round except in November.

Production differs considerably from that in Queensland. Most growers have at least some of their area under plastic tunnels which prevents rain increasing disease epidemics. This method also 'forces' production early after winter in most cases because of raised temperatures. Mother fern harvesting is the standard method of production. Also as a standard practice, ferns are trimmed to a height of 1.5m and lateral buds and lower ferns are removed to allow for better air circulation.

Growers expressed a strong desire for new cultivars with disease resistance particularly against Phomopsis stem blight. This disease is the main cause of concern to Japanese growers. They also see Stemphyllium leaf blight and some Purple Spot. Fusarium wilts are also common particularly on paddy fields previously used for rice production. Growers use fungicides, infected stem removal and rainout shelters to combat Phomopsis.

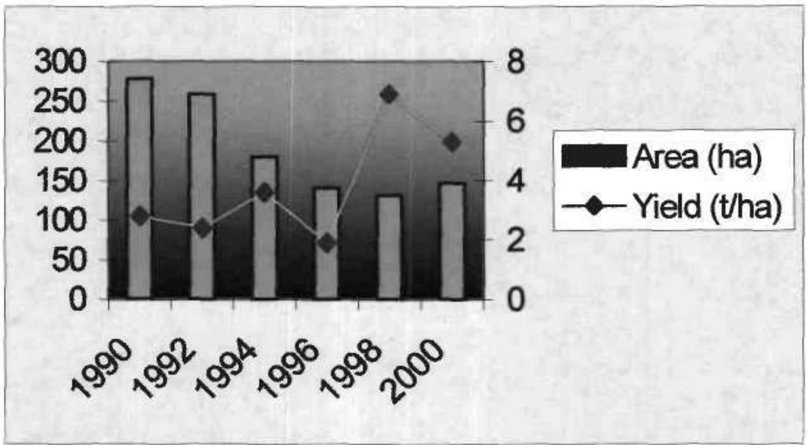
Gross income from asparagus in Nagano Prefecture varies considerably from $65,000/ha to $250,000/ha and growers net about half that after expenses. This means the 'average' farm nets between $8000 and $31000/year from asparagus.

Following this very informative meeting, the delegates attended a banquet lunch with the local growers for informal discussions. Although convivial, the informal discussions were constrained by the language barrier and there were not enough translators to cover the whole audience.

- **Asparagus farm visits in Fukushima Prefecture**

Asparagus production in this Prefecture has declined since 1990 when Phomopsis stem blight became a serious disease problem. Despite this, production has increased because methods have changed. Chiefly, harvesting now occurs over a much longer period because of the implementation of mother fern harvesting, semi-forcing during late winter and the use of tunnel plastic to exclude rain. Figure 3 indicates the decline in area of asparagus grown since 1990 due to Phomopsis stem blight.

Figure 3. Decline in the area of asparagus grown in Fukushima Prefecture due to *Phomopsis.*




Two growers were visited. Both experience problems with Phomopsis stem blight and need to commence disease control at spear emergence. They use an alternating program of benomyl and chlorothalonil and include Bordeaux mixture more frequently now than they have in the past. Spray frequency is every 4 days for 3 weeks following spear emergence. One grower also uses Topsin M and carbendazim as alternatives to chlorothalonil and benomyl.

It was very apparent these two growers (Mr Igarashi and Mr Ukawa) regarded Phomopsis stem blight as a very serious problem. Both grow asparagus under plastic and in open fields. Both remarked that the disease is much more difficult to contain when it rains and the crop is not covered. All asparagus was tied upright and not trailing into the inter-row spaces. Air movement was therefore facilitated and stems dry out much more easily than they would otherwise do.

This visit was an extremely useful field management information gathering exercise.

- **Symposium presentations**

Officially 130 delegates attended the 10th International Asparagus Symposium held in Niigata, Japan. Delegates attended from Austria, Chile, China, France, Germany, Guatemala, Honduras, Indonesia, Italy, Japan, The Netherlands, New Zealand, Peru, The Philippines, Poland, Spain, Thailand and the United States. I was the only representative from Australia. Delegates presented a total of 32 oral papers, and 30 posters were displayed during the Symposium. Subject areas covered throughout the three days included agronomy, production systems, cultivar evaluation, genetics and breeding, physiology, biochemistry, post harvest and pathology.

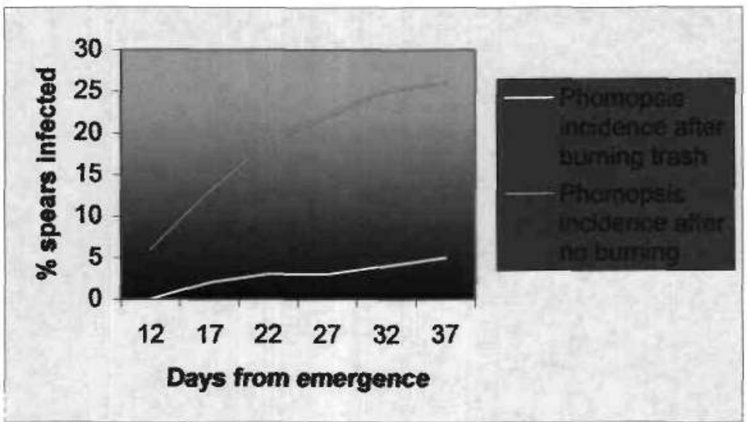
A key paper on "**The development of Asparagus in China**" was given by Dr Guangyu Chen from the Jiangxi Academy of Agricultural Sciences. While not a traditional crop in China, the country now produces enough quality asparagus for export mainly into Japan. This market is increasing, as is the domestic market as Chinese people learn how to use asparagus as a food themselves. Dr Chen stressed that the major disease problem was by far Phomopsis stem blight. He mentioned no other disease during his talk. He explained than the disease was capable of wiping out entire crops. He has observed that F1 hybrids are more resistant than F2s and purple cultivars are more tolerant than green cultivars. Their method of management includes a thorough clean-up of trash during winter followed by a good nutritional regime with particular reference to potash. Fungicides are applied before fern establishment and the chief method of applying the chemicals is by painting the spears as they emerge. Carbendazim is the main fungicide used. Phomopsis stem blight is a spring-summer disease and is present in all Provinces asparagus is grown. Chinese scientists have identified some strains of *Bacillus subtillus* with efficacy against this pathogen. During discussions with Dr Chen following his presentation, he emphasised the importance of Phomopsis stem blight and that in his opinion we should be considering destroying all asparagus with this disease here in Queensland because it is so difficult to manage. This is no longer an option for us in my opinion since it has now been recorded on a number of properties and covers a wide area of production around the Warwick region. It was particularly interesting to find out how important it is to commence fungicide applications immediately spears emerge. This view was backed up in discussions with Japanese pathologists. In China, if spears aren't painted, growers must apply sprays every 2 days for the first 15 days to avoid major losses as the ferns mature.

Dr Mike Nichols from New Zealand presented a paper on "**The production of year-round asparagus in a temperate climate**". Normally in a temperate climate harvesting is restricted to spring. It is possible to use the mother fern system or to take an autumn harvest but yields are not good in either situation. Since winter field harvesting is not possible, greenhouse production has become a strategy to extend the season. Greenhouse production prevents diseases establishing because rain is excluded and the system relies on drip irrigation. Normally in the field the plant population is around 40 000 plants/ha. In the greenhouse 4 times this density is possible. There are problems using a mother fern system in that fungicides are applied when spears are being harvested presenting residue problem in the market. This is believed to be an issue in the Philippines. Dr Nichols also explained that his studies indicated container grown plants could be stored in a cool store in the dark until required for forcing. This forcing can be done in a well-insulated building with minimal heating costs.

Another New Zealand paper presented by Dr Derek Wilson explained "***AspireNZ*: A decision support system for managing root carbohydrate in asparagus**". Soluble carbohydrate in the storage roots drives the performance of asparagus. Growth of spears and ferns during the crop's annual cycle is associated with a characteristic pattern of accumulation and depletion of root carbohydrate content. Deviations from the normal usually indicate crop performance is below optimum and can be used to diagnose and resolve problems. Dr Wilson and his colleagues have developed a computer system to interpret information collected from the crop to predict performance. It consists of 5 parts- assessment of carbohydrate in storage roots, an interactive delivery system, interpretation system, client registration and information distribution. It is only available to New Zealand growers. Growers determine the Brix level in roots and the Aspire system calculates the carbohydrate levels. The system helps to decide when to stop harvesting (early if the roots are low in carbohydrate) or later if a high level is determined. It also helps to decide whether to spray for Stemphyllium and this is usually not required if carbohydrate levels are high. This system will not be made available to Australian growers because of competition between Australia and New Zealand for the Japanese market.

"**Asparagus production in Japan, especially centring on Hiroshima Prefecture**" was the title of a presentation given by Dr Hiroyuki Kohmura. I was particularly interested in his comments regarding Phomopsis stem blight which is the major disease in Hiroshima as well as all other production areas of Japan. In Hiroshima, growers deliberately use rainout shelters to lower the risk of rain induced infections. They also burn stubble as a matter of routine and Figure 4 indicates the efficacy of this management tool.

Figure 4. The use of fire as a management tool for managing Phomopsis blight in Hiroshima Prefecture.




Growers use small hand-held gas burners to accomplish the trash burn which is carried out as soon as the old stems are completely dry. Mulching is considered very important since this covers any remaining infected trash and prevents splash infections from occurring. For this practice, pine bark mulch is used at a depth of 10cm over the rows. Chemicals are also used as soon as spears emerge. Once again carbendazim, benomyl, chlorothalonil and Bordeaux are the main fungicides used.

Dr Kohmura also spoke of the tendency in Japan for thicker spears over the last few years, particularly a trend to L and 2L class spears. They are attempting to breed varieties more suitable to this character and if Australia is to maintain or increase its role as an exporter of quality spears to Japan, perhaps new cultivars should be developed specifically for our conditions.

Among the other presentations, little further information was given of relevance to the diseases troubling Queensland growers at the moment.

- **My presentation**

I presented a paper entitled "**Management of three newly recorded asparagus diseases in Queensland will require adoption of new production strategies**". The Symposium was presented with the history of the discovery of rust, Phomopsis stem blight and anthracnose in Queensland asparagus during 2000. An explanation of how we are attempting to manage these diseases was given and how the expected distribution of the diseases will eventually mean all asparagus growing areas of Australia will need to consider management of some kind. The paper generated some discussion particularly from the New Zealand contingent that feels particularly threatened by these diseases.

A copy of my Paper and my PowerPoint presentation are attached in this Report.

# IMPLICATIONS FOR AUSTRALIAN HORTICULTURE

## The Diseases

**Rust** This disease is neither as widespread nor as a serious problem as I had originally thought and its implications for Australian asparagus producers are probably not as significant as originally feared. It seems it fluctuates in significance in some areas such as Washington State in the USA and in southern Italy and Spain. It is hardly ever a problem in France and never in other European countries like Poland, Austria, Germany and Holland. It was a problem in a single year in Peru and although it still appears in crops there, it has never since reached significant proportions since. In California it fluctuates in importance also but is ever present. It does not appear to be a significant problem anywhere in Asia or SE Asia. It does occur in most countries in the region but nobody thought it was worth worrying about. I did not see any rust on the farms visited in Japan although the disease has been recorded there.

Rust is managed by removal of old trash (burning, burying etc) and with fungicides. In some countries, crop monitoring is carried out and crops are sprayed only when signs of rust are present. Usually no more than 3 sprays are required. Fungicides used elsewhere include Score, Systhane, copper fungicides and sulphur. In Europe and the USA, Bayer is keen to get tebuconazole (Folicur) registered for use against asparagus rust. This fungicide is available in Australia for use on other crops. These management methods can easily be adopted under Australian production systems and research on this disease should need only to centre on registration of suitable fungicides and recognition of critical application timing.

**Phomopsis stem blight** This disease is by far the primary disease in China and Japan. Phomopsis has resulted in a lowering of Japanese production during the last 20 years but it may now be on the way back. There was a delegate from Taiwan who didn't seem to know anything about it in that country which was I found surprising. Also, I had understood it was a significant issue in the Philippines for the food company Dole, but after a lot of discussion with several of their people at the Symposium it appears to be only of minor significance there. It is present in Indonesia but apparently not significant. It occurs in Thailand but the delegate told me it wasn't important there either. Phomopsis stem blight is not found anywhere else.

It was readily apparent that Phomopsis stem blight remains an important disease in China and Japan because it is so difficult to control. Both countries have adopted strategies which would not be applicable to our production systems, simply because their systems are much smaller in the size of individual operations and in the case of China, labour is so inexpensive.

In Japan, trash removal is done meticulously. Burning is rarely done now because of the incomplete nature of the operation although it is still practised in some areas. They remove as much as they can by hand from the field and mulch the surface heavily with pine bark mulch to cover diseased trash. In China they still burn their trash using small hand-held gas burners and plenty of people to sweep up all the trash.

Certainly there are lessons here for Australia in regard to trash management. It seems imperative that lowering (and indeed preventing the chance of build-up) of *Phomopsis asparagi* inoculum over winter is a key strategy in managing this disease. There are some avenues that could be explored here in a holistic disease management project.

Fungicides are the other key tools in Japan and China's management programs. In Japan, sprays are applied apply every 5-10 days during spear emergence and growth. In China, the frequency comes down to every second day for the first 15 days after first spear emergence. In both countries the main fungicides used are Benlate, Carbendazim, Bravo, Topsin-M, copper fungicides and Bordeaux mix. Currently there are no fungicides registered for use against Phomopsis and this is of real concern. It is imperative that work begins on screening chemicals under Queensland conditions and investigations commence to determine critical application timings.

Spray application volumes used in Japan are high compared to those used commonly here. Japanese growers apply up to 4000L/ha to make sure they penetrate the fern to cover emerging spears. This is the most important time to apply fungicides. In China, coverage is regarded as so critical that painting spears with fungicides are preferred to spray applied treatments. The Chinese method is obviously not applicable under Australian conditions but there is certainly scope for a critical look at spray technology.

Also in Japan, by covering asparagus crops during the wet season with clear plastic to keep rain off helps enormously in lowering infections. The rationale is obviously to prevent fern wetting as a means of distributing and establishing new infections. While the method of achieving this through rain-out shelters is of limited or no use in Queensland production systems, perhaps the use of trickle tape irrigation instead of overhead sprays would have a significant impact on Phomopsis stem blight movement within crops.

**Anthracnose** It became apparent that none of the delegates was aware of the disease anthracnose. This was a little surprising since it was expected that those from countries neighbouring our north would have come across such a serious pathogen as *Colletotrichum gloeosporioides*. I have an opinion that anthracnose does exist in the tropical production areas to our north and it may be misdiagnosed as Phomopsis stem blight because of the similarities in symptomatology. While researchers from other countries were keen to find out more about anthracnose from the Queensland angle, it appears we must develop our own research direction with this disease.

**Other diseases** Fusarium crown and root rots seem to be the most widespread of all asparagus diseases and were the topic of several discussions. Work on them is being conducted in Europe and the USA. Cercospora leaf and stem blight is the main disease in the Philippines and it takes a lot of effort to spray for it (they use Score and copper sprays). Stemphylium is also an issue in most countries. Botrytis blight was an unknown disease to me (it was present in the Japanese asparagus I saw) and it is a major problem in Poland also. Phytophthora was also seen in Japan and it is present all over the world also.

Some work is underway in Victoria already to determine a control strategy against Stemphylium and purple spot disease. There are no current projects looking at management of Fusarium and Phytophthora diseases although both are present but sporadic under Australian conditions. While they remain of minor importance there is little likelihood producers will require a targeted research program.

The information gathered during this Symposium was limited only by the time spent in the company of other delegates. I found a lot of benefit in discussions with delegates between sessions and at the Poster displays. Disease management in Queensland will need to be addressed by producers if they wish to maintain any market advantage or even continue to produce the yields they've come to expect. Many changes will need to be made in order to achieve this end.

# INFORMATION DISSEMINATION

Prior to departure, 2 meetings were held with Queensland asparagus grower groups to gather information regarding the current disease status here. Field surveys were also conducted on all properties known to be producing asparagus and the most relevant and up-to-date information was used to develop my symposium paper (attached). The symposium paper will be published in *Acta Horticulturae* later in 2002 (attached).

Following the symposium, I convened a meeting of growers to give my impressions and preliminary observations on the outcomes. This meeting was well attended by 28 growers and all had an opportunity to interact and comment on my presentation which I distributed to all. I provided handouts which I obtained in Japan for distribution to those interested. This meeting was held in Dalby on October 17, 2001.

In addition, visits have been made to all those producers who provided funds to undertake the trip to Japan to enable them to comment and question me directly on the outcomes. This has included visits to producers in north Queensland, south Burnett and Warwick.

I have undertaken to provide a copy of this Final Report to all growers who contributed funds towards the visit.

# ITINERARY

Day 1. (27.08.01) Depart Brisbane for Tokyo. Overnight Tokyo

Day 2. (28.08.01) Begin pre-Symposium tour. Visited Tokyo main markets. Meeting to discuss asparagus marketing in Japan. Travel to Nagano. Overnight Nagano.

Day 3. (29.08.01) Pre-Symposium tour to asparagus farm in Nagano Prefecture. Discuss production with Japanese grower. Discuss asparagus production in California and New Zealand at a meeting attended by more than 50 Japanese asparagus growers. Travel to Niigata. Overnight Niigata.

Day 4. (30.08.01) Symposium opening day. Presentations from delegates on production in various countries. This day was attended by about 20 Japanese asparagus growers. Overnight Niigata.

Day 5. (31.08.01) Field trip to visit 2 asparagus farms in Fukushima Prefecture. Discuss production with growers. Return and overnight Niigata.

Day 6. (01.09.01) Symposium presentations from delegates. Symposium dinner. Overnight Niigata.

Day 7. (02.09.01) Symposium presentations. My presentation to Symposium. Closing ceremony. Return to Tokyo. Return to Brisbane (arrived at 7:00am Day 8).

# RECOMMENDATIONS

- To facilitate progress in times of industry crisis, it is recommended Queensland growers form into an identifiable industry group. Disease research work may well have already commenced had such a representative body been in place.

- The difficulties in liaising with individuals rather than a body would also be overcome if the Australian asparagus industry was a contributing member of Ausveg. I encourage asparagus growers nation-wide to consider taking this step.

- It is axiomatic that research should commence to examine all aspects of the epidemiology and management of asparagus rust, Phomopsis stem blight and asparagus anthracnose if these diseases are to be fully understood. A project proposal currently being developed by New Zealand researchers should be closely examined and if acceptable be supported as a means to this end.

- Fungicides need to be screened and suitable chemicals registered for the control of these diseases. It is not essential that registration is pursued through the above-proposed project, but that seems a logical approach.

- There is a lot of information available from countries like Japan and China which have been dealing with Phomopsis blight for several years and close contact should be maintained with these researchers. Regular contact will prove well worthwhile especially in the early stages of developing any project work.

## ACKNOWLEDGMENTS

This visit would not have been possible without the dedication and support of Queensland asparagus growers, in particular Soc and Robyn Kienzle who took it upon themselves to organise the fund raising. My thanks to all involved.

I am also obliged for the support of HAL. The proposal was rapidly processed and approved without any unnecessary delay.

The Queensland Department of Primary Industries gave approval for my attendance at the Symposium.

# CONTACT LIST

Several important contacts were made during the course of the week in Japan. Probably the most significant were the pathologist from Japan and China. Dr Sonoda who works in the Fukushima Prefecture will be very useful in ongoing discussions about Phomopsis blight management as will Dr Chen from China. Both appear very keen to help with ideas and express an on-going interest in the disease situation in Queensland. I also developed a strong relationship with New Zealand researchers, Drs Peter Falloon, Derek Wilson, and Phillip Schofield. Dr Brian Benson from California has promised to maintain contact since he breeds and supplies many of the asparagus lines used in Australia. He suggests that our rust pathogen may well be different from the strains existing in the USA.

I have also established links with asparagus researchers in Indonesia, Thailand and the Philippines. Although none of these people are pathologists, they have an interest in the developing disease situation in Australia. These contacts include Mrs Tino Onggo, Dr Somboonsarn and Mr Cueto.

Several other delegates expressed interest in Queensland asparagus production. It was felt by most that having someone attend the Symposium from Australia indicated we were serious players on the export scene and many wanted to find out more about our role in that trade. Some indicated surprise that no one else from Australia attended the meeting.

Following is a list of useful contacts made at the 10th International Asparagus Symposium and with whom I have maintained a professional relationship:

1. Dr Aage Krarup
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## *Attachment 1*

Prepared scientific paper delivered at the Symposium.

# MANAGEMENT OF THREE NEWLY RECORDED ASPARAGUS DISEASES IN QUEENSLAND WILL REQUIRE ADOPTION OF NEW PRODUCTION STRATEGIES

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**Keywords:** rust, Phomopsis blight, anthracnose, *Puccinia asparagi*, *Phomopsis asparagi*, *Colletotrichum gloeosporioides*, disease control

**Abstract**

**During March 2000-March 2001, three fungal diseases were recorded for the first time on *Asparagus officinalis* in Queensland, Australia. Rust (*Puccinia asparagi*) was restricted to a single farm initially. The property was quarantined and although the affected asparagus crop was destroyed, rust has since been recorded on most properties within a 250 km radius of this initial recording. The disease has been found on all cultivars currently being grown in Queensland but pathogenic specialisation has not yet been determined. The fungicides myclobutanil, difenoconazole and mancozeb have been approved under permit conditions to be used for rust control in Australia. Phomopsis blight caused by *Phomopsis asparagi* appeared on a group of properties and resulted in fern death and subsequent debilitation of affected stands. All cultivars have become diseased but fungicide screening has indicated benomyl, chlorothalonil and difenoconazole have significantly ($P<0.05$) restricted disease development (3-16 lesions/stem). Other fungicides including, mancozeb, copper-oxychloride and azoxystrobin were not as effective against Phomopsis blight (19-26 lesions/stem). *Colletotrichum gloeosporioides* is the causal pathogen of the third disease, anthracnose. Anthracnose has previously been reported as a serious stem disease of asparagus in the Northern Territory of Australia but little is known of its distribution elsewhere. This disease is so far restricted to Queensland's tropical production areas. Fungicides such as mancozeb, chlorothalonil, benomyl and azoxystrobin are used successfully to control *Colletotrichum* spp. on other hosts and may also prove useful in controlling epidemics in asparagus. Presently these diseases are unknown in the major asparagus production areas in other Australian states but it is probably inevitable pathogen dissemination will eventually occur within the country. New disease management strategies involving fungicides, trash destruction, production hygiene, balanced nutrition and host resistance are discussed in relation to current asparagus production methods in Australia.**

## INTRODUCTION

Until summer 2000, asparagus foliar diseases were of minor concern to most producers in Australia. *Stemphylium vesicarium* (Wallr.) E. Simmons infections have probably been the predominate diseases encountered (purple spot of spears and Stemphylium blight of fern), but until recently these have not required serious management inputs. Purple spot has been of more recent concern in some areas and has attracted some research funding in Victoria (P. Brown, personal communication). In Queensland, cladophyll and stem blights caused by *Stemphylium* spp. and *Cercospora asparagi* Sacc. have occasionally been controlled with fungicides depending on seasonal severity and decisions taken by individual growers. Generally though, small scale production enterprises in Queensland have not embraced the notion of disease management of any kind, relying instead on the usually infrequent occurrence of disease-conducive seasonal conditions which preclude the prospect of serious production losses.

Asparagus production in tropical Australia suffered a major setback during the mid-1990s as a result of infection with *Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc. in Penz., and by 1997 all asparagus farms in the Northern Territory harboured the disease (J. Bright, personal communication). The pathogen produced serious symptoms on stems during the humid summer months (Conde *et al.* 1999). Anthracnose has curtailed further expansion of the industry there and production on some properties has been abandoned (S. Bellgard, personal communication). An extensive literature search has failed to find evidence this disease is of concern in other asparagus producing countries. Since the outbreak of anthracnose in the Northern Territory, asparagus production commenced in northern Queensland, another tropical area. The disease has recently been recorded from this region also.

Rust, a common foliar disease of asparagus in the northern hemisphere (Elmer *et al.* 1996), was not present in Australia before 2000. The disease was found initially on a single property in southern Queensland confined to a young crop of UC 157. Property quarantine and crop destruction failed to contain the pathogen and the disease is now endemic throughout all southern Queensland production regions (Davis, 2001a). Phomopsis blight, caused by *Phomopsis asparagi* (Sacc.) Bubak is a serious disease throughout tropical and sub-tropical asparagus production areas in Asia and SE Asia (Liu *et al.* 1988, Xu-Helin *et al.* 1993, Sonoda *et al.* 1997), but before 2001 had never been recorded in Australia (Davis, 2001b). This disease is more restricted in its present Queensland distribution than rust. Neither anthracnose, rust nor Phomopsis blight has been found in other regions of Australia.

Quite suddenly, asparagus producers in Queensland face the prospect of managing three newly recorded foliar diseases where previously there has not been any regularly threatening foliar disease problem. Queensland producers will no doubt be able to adopt many of the strategies developed in other countries to control diseases such as rust and to some extent, Phomopsis blight. Some of these strategies may also be important in managing anthracnose. The success of future disease management also depends on the industry developing practical solutions through local research. This paper reports some of the research already undertaken, and discusses strategies under consideration in Queensland to defend asparagus against rust, Phomopsis blight and anthracnose.

## MATERIALS AND METHODS

Two field experiments were established on summer regrowth of asparagus following early summer spear harvest on two farms in southern Queensland. At the time of establishment, rust had not been found beyond the initially recorded infestation on another property. All asparagus on that property had been destroyed. Consequently the aim of these field experiments was to examine a range of fungicides for their efficacy against *Phomopsis asparagi.*

In the first experiment, azoxystrobin (300 g ha$^{-1}$ Amistar), benomyl (1 kg ha$^{-1}$ Benlate), chlorothalonil (2 L ha$^{-1}$ Bravo), mancozeb (2 kg ha$^{-1}$ Dithane), copper oxychloride (4 kg ha$^{-1}$), difenoconazole (500 mL ha$^{-1}$ Score) and acibenzolar-S-methyl (0.05 g L$^{-1}$ Bion®) were applied with and without the phospholipid spray adjuvant LI 700® (5 mL L$^{-1}$). The second experiment examined the same chemicals and rates alone and in an alternating program (azoxystrobin/chlorothalonil, azoxystrobin/mancozeb, azoxystrobin/copper oxychloride, azoxystrobin/Bion®; and benomyl/chlorothalonil, benomyl/mancozeb, benomyl/copper oxychloride, benomyl/Bion®). All applications in this experiment were accompanied with the ethylated-esterified vegetable seed oil spray adjuvant Hasten® (1 mL L$^{-1}$). The applications were made according to a 7-14 day schedule depending on rainfall (weekly applications during wet weather extending to fortnightly if conditions remained dry).

The first field trial contained 15 treatments which were replicated four times in a randomised block design. The second experiment contained 16 treatments replicated twice in a randomised block. Plots in both experiments were three adjacent, 4 m rows separated by single unsprayed rows between treatments. Chemical application was made with a propane-pressurised backpack sprayer through an adjustable hollow cone nozzle at an initial rate of 200 L ha$^{-1}$, increasing to 800 L ha$^{-1}$ maximum at full fern.

Data were taken from the middle rows only. Single, recently emerged spears were tied with coloured plastic tape (flagged) in all treatments in both experiments for the duration of the work. These spears had elongated to between 20-40 cm at the time of flagging. In the first experiment, new spears were flagged on four occasions (day 0, day 12, day 24 and day 45 from the first flagging). New spears were flagged on five separate occasions in the second experiment (day 0, day 4, day 17, day 28 and day 43 from the first flagging). No Phomopsis blight was apparent on these spears when flagged and symptom expression was recorded on them weekly for the duration of the experiments.

At the second experimental site, an autumn harvest was carried out at the conclusion of the work. No yields were taken, but six spears/plot were flagged on emergence, over a two-week period and harvested two days later. Harvested spears were incubated at near-100% RH in a laboratory for seven days. Incubated spears were then inspected for Phomopsis blight.

An automatic weather recording station (Environdata™) collected hourly air temperature, relative humidity, leaf wetness, rainfall and soil temperature (at 10 cm below the soil surface) data at the second site only.

## RESULTS

### Experiment 1

The total and mean numbers of flagged spears which became infected with *Phomopsis asparagi* are shown in Table 1. All chemical treatments had significantly fewer diseased stems than the untreated control ($P < 0.05$). Only two of the 16 flagged spears in the benomyl sprayed plots became diseased compared to 11 of the 16 in the untreated control plots. Benomyl-treated plots also contained significantly fewer diseased stems than developed in the azoxystrobin treatments (with and without LI 700®), but there were no differences between benomyl and the other fungicides used. LI 700® did not improve efficacy of any of the fungicides.

A mean of 6.5 lesions developed on flagged stems in the untreated control plots in this experiment (Table 1). Both benomyl and chlorothalonil (with and without LI 700®) contained significantly fewer stem lesions resulting from infection with *Phomopsis asparagi* than the untreated control ($P < 0.05$). Benomyl was also significantly superior to mancozeb (0.75 lesions cf 4.75 lesions); and benomyl and chlorothalonil were both significantly better than azoxystrobin with LI 700®, mancozeb with LI 700®, copper oxychloride (with and without LI 700®) and Bion®.

**Experiment 2**

No significant differences were indicated in the flagged spear data obtained from the second field experiment (data not presented here). However, while Phomopsis blight appeared on one or more flagged stems in most treatments, no lesions developed in any of the benomyl or chlorothalonil treated plots.

An overall assessment of disease incidence in each plot was made immediately before an autumn harvest of spears from this production area (Table 2). The data are not significant, however 60.6% of stems in the datum rows of the benomyl alternating with chlorothalonil treated plots remained disease-free at this time (4 weeks after the final application) compared to 44.6% healthy stems in the untreated plots.

Disease occurrence could not be correlated with any of the recorded weather parameters taken from within the experimental site. Phomopsis blight infections developed throughout the course of the experiment regardless of rainfall and leaf wetness patterns. No extraordinary disease development occurred despite periods of extended rainfall and conducive conditions (three periods of more than 4 consecutive wet days and leaf wetness in excess of 12 continuous hours).

**DISCUSSION**

Experiments have commenced in Queensland to establish sound disease management practices to combat the sudden and unexplained appearance of the asparagus diseases rust, Phomopsis blight and anthracnose. Two field experiments have been concluded seeking to identify useful fungicides that could become integral in managing Phomopsis stem blight. During the course of these experiments, rust became endemic across the major production areas of the state but the disease did not establish at the Phomopsis blight experiment sites. Consequently no information was obtained on the efficacy of the chemicals against *Puccinia asparagi* DC. Anthracnose remains confined to the tropical production areas more than 750 km from the southern regions where rust and Phomopsis blight are active. Likewise, rust and Phomopsis blight have not been found in the tropical areas. It is planned to examine a selected range of fungicides for their efficacy against *Colletotrichum gloeosporioides* under glasshouse conditions. It is apparent that both benomyl and chlorothalonil are worth consideration and they will be examined further in fieldwork against Phomopsis blight. In Australia, emergency permits were issued for the use of myclobutanil, mancozeb and difenoconazole to manage the rust incursion, but these fungicides may have little or no application in a Phomopsis blight control program. Future fungicide experimentation will focus on trying to develop a single program with Phomopsis blight, anthracnose and rust control capabilities.

An observation made at both field experiment sites was that Phomopsis blight initially appeared on secondary stem growth high on the ferns. This contrasts with observations reported elsewhere (Hsu *et al.* 1969, Sakai *et al.* 1992a) where the disease is noticed initially at or near the base of the fern. During 2001 in Queensland, it appeared that inoculum was entering from sources external to the experiment sites rather than from infected debris lying in the plots. Tu *et al* (1981) regarded significant airborne inoculum dissemination was probably negligible without rain. An attempt was made at both sites to remove trash remaining from previous growth but this was not completely successful and the presence of inoculum was confirmed on old plant material. The lesions that developed in the upper fern growth appeared to provide the inoculum source for larger and potentially more destructive symptoms on lower, primary stem growth.

Most stem blight lesions developed on the flagged spears within 2 weeks of emergence at both experimental sites. No new lesions were recorded on main stems older than 23 days after emergence. Although no spear yield information was gathered from either experiment, samples of spears taken from the plots at the second site did not indicate Phomopsis blight infection had taken place during the 3-week harvest period. While it was not unequivocally established that *Phomopsis asparagi* could infect emerging growth in the field, grower observations were that symptoms resembling Phomopsis blight infections (unconfirmed) did appear on some harvested spears from the same production area. Snowdon (1991) previously indicated spears could become infected.

Although unreported here, work was also commenced in 2001 to examine commercial fungicide application systems for their efficacy in delivering chemicals to potential infection sites in fully-ferned asparagus crops (Davis and Geitz, unpublished data). It is obviously very important to effectively target fungicides and the practicalities of achieving this commercially in asparagus crops can be problematic. This work will continue in conjunction with screening for effective fungicides and defining the optimum timing of their delivery. It is thought that while Queensland producers may not be applying sufficient volume of spray to achieve effective coverage to manage Phomopsis blight, current spraying systems may possibly be capable of adequately targeting crop growth for *Puccinia asparagi* control. In view of the observation that new growth appears most at risk of infection by *Phomopsis asparagi*, the timing and frequency of effective chemical applications will probably prove difficult to achieve as indicated by Tu (1985).

Formal experimentation has not yet commenced to examine the potential of practices such as trash manipulation following harvest and the effect of plant nutrition on the incidence and severity of Phomopsis blight, anthracnose or rust. Such strategies are used in other countries with some success (Kuang *et al.* 1988, Sakai *et al.* 1992b). However, some producers have embarked on programs that address these in relation to disease management. The rationale for addressing both comes from the recognition that old growth remaining after harvest undoubtedly contains a potential reservoir of inoculum for all three diseases, and that plant stands that have become nutritionally compromised probably tend to suffer more severely from the debilitating effects of diseases like these.

Crop hygiene practices in relation to stem blight and rust inoculum reduction have been developed and encouraged elsewhere (Tu 1985, Kuang *et al.* 1988, Mullen *et al.* 1996), and these practices will be examined in the Queensland context in future work.

There does not appear to be much prospect of reward in searching for high levels of resistance for either Phomopsis blight or rust within current hybrids, although some cultivars are more resistant than others. For example, cvv. UC 157, Grande, Thukikou 2Gou and Apollo suffered only moderate levels of Phomopsis blight compared to some European cultivars (Sonoda *et al.* 1997), and cvv. Jersey Centennial, UC 157 and Jersey Giant exhibited some rust resistance in the USA compared to cv. Mary Washington (Johnson *et al.* 1993). Nevertheless, these cultivars do not always offer substantial production gains over less resistant material possibly because most are composed of heterogeneous populations. Resistance to anthracnose has not apparently been reported. Pathogenic specialisation within the populations of all three pathogens has yet to be determined in Queensland. While resistance alone does not seem to provide a complete answer to the management of these diseases, suitable hybrids and cultivars may be identified that could have a place in an integrated disease management system. With this in mind it is planned to examine the disease reactions in a range of cultivars and breeding lines when exposed to infection in the field and glasshouse.

Integrated disease management based on the responsible use and strategic timing of suitable fungicides, sound nutrition, host resistance and new cultural strategies will enable Queensland producers to continue to provide the market with high quality asparagus into the future. The prospect should also be faced by producers in other Australian states, that since three new foliar diseases are now present in the country, disease management elsewhere will inevitably become axiomatic.

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Table 1. Phomopsis stem blight incidence on flagged stems in experiment 1.

| Treatments | No. of stems affected | | No. of lesions/stem | |
|---|---|---|---|---|
| | Total | Mean | Total | Mean |
| Benomyl | 2 | 0.5 a | 3 | 0.75 a |
| Benomyl + LI 700® | 3 | 0.75 ab | 3 | 0.75 a |
| Chlorothalonil | 4 | 1.0 abc | 9 | 2.25 abc |
| Chlorothalonil + LI 700® | 3 | 1.0 abc | 6 | 1.50 ab |
| Difenoconazole | 4 | 1.0 abc | 14 | 3.50 abcd |
| Difenoconazole + LI 700® | 4 | 1.0 abc | 16 | 4.0 abcd |
| Mancozeb | 4 | 1.0 abc | 19 | 4.75 bcd |
| Mancozeb + LI 700® | 5 | 1.25 abc | 24 | 6.0 d |
| Bion | 4 | 1.25 abc | 21 | 5.25 cd |
| Bion + LI 700® | 4 | 1.0 abc | 16 | 4.0 abcd |
| Copper oxychloride | 5 | 1.25 abc | 24 | 6.0 d |
| Copper oxychloride + LI 700® | 5 | 1.25 abc | 26 | 6.50 d |
| Azoxystrobin | 7 | 1.75 c | 16 | 4.0 abcd |
| Azoxystrobin + LI 700® | 6 | 1.5 bc | 21 | 5.25 cd |
| Untreated control | 11 | 2.75 d | 26 | 6.50 d |

Means followed by the same letter within columns do not differ significantly at $P < 0.05$ using Fisher's protected LSD test.

Table 2. The percentage of stems with symptoms of stem blight at the final assessment in experiment 2.

| Treatments | % stems affected |
|---|---|
| Benomyl alternated with chlorothalonil | 39.4 |
| Benomyl alternated with mancozeb | 44.5 |
| Azoxystrobin alternated with Bion® | 47.6 |
| Benomyl | 50.5 |
| Untreated control | 55.4 |
| Azoxystrobin alternated with mancozeb | 55.5 |
| Benomyl alternated with copper oxychloride | 57.6 |
| Bion® | 59.4 |
| Mancozeb | 61.5 |
| Difenoconazole | 62.0 |
| Azoxystrobin alternated with chlorothalonil | 62.3 |
| Copper oxychloride | 68.5 |
| Azoxystrobin alternated with copper oxychloride | 68.8 |
| Benomyl alternated with Bion® | 72.8 |
| Chlorothalonil | 73.8 |
| Azoxystrobin | 76.0 |

No significant differences were found between treatments using Fisher's protected LSD test.

## *Attachment 2*

PowerPoint presentation delivered at the Symposium.

## 3 new asparagus diseases arrive in Australia....

## ....how will we manage?

Bob Davis Agency for Food and Fibre Sciences Gatton Research Station 1

**1.Phomopsis blight**

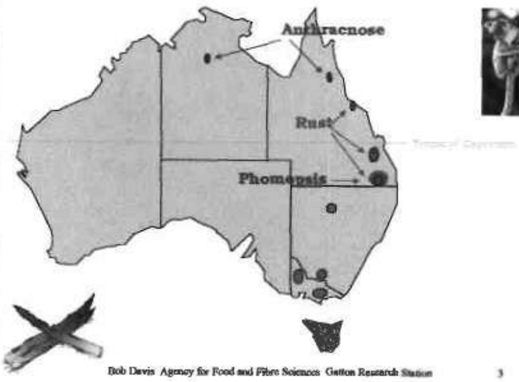
**2.Rust**

**3.Anthracnose**

**(Stemphylium)**

**(Cercospora)**

Bob Davis Agency for Food and Fibre Sciences Gatton Research Station 2




Bob Davis Agency for Food and Fibre Sciences Gatton Research Station 3

## Where did these diseases come from...

Bob Davis Agency for Food and Fibre Sciences Gatton Research Station 4

## Management options...

**anthracnose**

Bob Davis Agency for Food and Fibre Sciences Gatton Research Station 5

## Management options...

**Phomopsis blight**

Bob Davis Agency for Food and Fibre Sciences Gatton Research Station 6

## Management options...

rust

Bob Davis Agency for Food and Fibre Sciences Gatton Research Station 7

## Where will these diseases go next...


Bob Davis Agency for Food and Fibre Sciences Gatton Research Station 8

## My attendance is sponsored by

## The Asparagus Growers of Queensland & Horticulture Australia Ltd

Thank you

Bob Davis Agency for Food and Fibre Sciences Gatton Research Station 9